

REVIEW OF BICYCLE IMPACT ON HUMAN BODY

by John Shuttleworth^[01] 31 July 2023 (Revised 24 August 2023)

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Potential Effects on Older Adults from Bicycle Impacts

<https://www.hopkinsmedicine.org/health/conditions-and-diseases/osteoporosis/osteoporosis-what-you-need-to-know-as-you-age>

Bone is constantly being dissolved by the body and replaced with new, daily. Until about age 25, the body adds more bone than it takes away, so bone density increases. From about age 25 to age 50, bone density tends to stay stable with equal amounts of bone formation and bone breakdown. After age 50, bone “resorption” outpaces bone formation and bone loss often accelerates, particularly at the time of menopause.

Broken bones tied to increased risk of death up to 10 years after impact.

By Shereen Lehman, Reuters Health

<https://www.reuters.com/article/us-health-elderly-fractures-idUSKBN1KU2BC>

After fractures of the upper arm bone, clavicle or rib, risk of death rose by 5 percent to 10 percent, and by 3 percent for a lower-leg break. With an upper- or lower-leg break, a small but statistically meaningful risk persisted for five years, the researchers found. With a hip fracture, the increased risk lasted for 10 years.

(Reuters Health) - The increased risk of dying after older adults break a bone is real, long-lasting and it's not limited to hip fractures, researchers say.

SOURCE: bit.ly/2vbjQ1R Journal of Clinical Endocrinology & Metabolism, online July 19, 2018.

These studies have established a heightened risk of death after elderly people break a hip or vertebra, and that it is at least partly driven by the short-term risk of developing pneumonia or other complications while immobilized during recovery.

An analysis of mortality among people aged 50 and older in Denmark found an increase in mortality risk of up to 25 percent with other types of fractures as well. Even with hip fractures, the “excess” risk of death remains slightly elevated for at least 10 years, the study team reported in the *Journal of Clinical Endocrinology & Metabolism*. Senior study author **Jacqueline Center** told Reuters Health:

“Although there are many studies looking at what happens after hip fracture, there have never previously been large enough data sets to look at other specific fracture types to identify for how long the increased risk of dying lasts.”

“For older people who break a bone, the risk of death goes up - and that risk can stay high for years. This is true for most fracture sites, including the upper arm, spine, rib, pelvis, and hip.”

Importantly, the risk of dying is highest in the year immediately after the fracture was noted.

The Danish national register monitored the diagnoses and health care use of the entire population of Denmark over many decades. Using the register, the researchers identified more than 21,000 women and nearly 9,500 men aged 50 and older who experienced bone fractures in 2001. The study team followed their fates through medical records for the next 10 years, and also compared them to similar adults without bone fractures.

Of the 21,000 women and 9,500 men studied 10,668 women and 4,745 men died during the follow-up period. After adjusting for the average mortality rates from other causes among people without bone fractures, the researchers calculated the excess mortality risk linked to having had a fracture.

During the year immediately after breaking a hip, men faced a 33 percent higher risk of death and women had a 20 percent higher risk, they found. Femur or pelvic fractures not involving the hip were associated with risk increases of 20 percent and 25 percent, respectively, while vertebral fractures were linked to a 10 percent risk increase.

This research highlights the important contribution of a wide variety of fragility fractures other than hip to excess mortality. “While hip fractures are regarded as significant and recognized as causing increased mortality, non-hip fractures are often seen as not being very important. The study highlighted the need for early intervention following any low-trauma fracture to minimize the wide treatment gap that is present internationally.

There are likely other trauma mechanisms behind these deaths that are not yet clarified. Earlier studies found the addition of other health conditions like heart disease or diabetes further increased the risk of dying after a fracture event.

It is important to keep in mind that severity of body damage can result from a fall equal to, or greater than, that from an impact.

Bicycle tires and human body parts have a certain amount of absorbency during an impact. A fall against Concrete or steel (such as a person onto a sidewalk or into an automobile or lamp post) where these materials have no resilience the impact is maximized. Additional consideration must be given to an older person’s response time to a collision as defensive reaction is greatly reduced.

The risk of broken bones increases by 1.5 to 2 times with each 1-point drop in the T-score*. For an older person it follows that half the impact force can do as much damage as that to a person with stronger bones.

(*See below for bone density tests.)

TECHNICAL ANALYSIS

<https://recuperatery.com/>

Article/how-much-force-does-it-take-to-break-a-bone?

University of Southern California estimates that a force of 3,300 Newtons (784 lbf) has a 1 in 4 chance of cracking a person’s rib, while a femur typically takes more force to break: around 4,000 Newtons (899 lbf). There isn’t a set number for what force will break a bone like a rib because how the force is applied makes a difference. A blow perpendicular to the bone is going to do more damage than when that same force is applied almost parallel. Bones are great at taking compressing forces but can’t deal too well with shear forces like a car or bicycle impact.

Certain people have stronger bones, depending on their diet, age, and lifestyle. Bones are dynamic: constantly being absorbed and reformed in a process called resorption. A big component of bone is calcium. A diet low in calcium means bones will probably be more brittle.

Human bones reach a peak density around age 30 and then begin to decline when the resorption of bone happens faster than formation. This can lead to osteoporosis. An estimated 55% of people over 50 have osteoporosis to some extent.

<https://www.discovery.com/science/force-to-break-bone>

It takes about 4,000 Newtons (899 lbf)* of force to break the typical human femur.

*lbf = foot pounds ft/s = feet per second km/h= kilometers per hour

SUMMARY OF FACTORS

The factors in this summary take human weight plus that of a bicycle as total mass then multiply that by the velocity of typical bicycle speeds. The riding speed is assumed to be the speed at impact.

Average Bicycle Weight:

Aluminum or steel road bikes:	20 to 25 pounds.
Touring bike:	26 to 33 pounds
Carbon road bikes:	18 pounds.
Gravel road bike:	18 to 30 pounds
Aero bike:	16.53 pounds

Average Bicycle Speed (Velocity):

The average road bike speed on a flat road :	17-22 mph or 28-35 km/h.
The average person rides at around:	12.6 mph.
However, a typical road cyclist:	15-18 mph (24-29 km/h).

Average adult weight: 180 to 200 pounds (mass)

Assume bicycle rider weighing: 170 lbs (mass) and a bicycle of 20 lbs (mass) = 190 lbs (mass) riding at the following velocities:

Impact Velocity

12 mph = 17.6 ft/s
15 mph = 22 ft/s
20 mph = 29.333 ft/s

RESULTS of FACTORS

Weight	Velocity	Force	Results
190lbs x	12mph = 17.6 ft/s* =	3344 lbf/s*	Can break bones.
190lbs x	15mph= 22 ft/s =	4180 lbf/s	Can break large bones and cause concussions.
190 lbs x	20mph= 29.33ft/s =	5572.7 lbf/s	Can break large bones, cause concussions and damage internal organs.

Velocity	Force	Force in time = Intensity
*ft/s = feet per second	*lbf = foot-pounds	*lbf/s = foot pounds per second

All of the above will vary by angle of impact and age and health of person struck.

Bones that tend to break most often are the hip and spine, DEXA usually measures bone mineral density in these bones. A DEXA scan is a type of medical imaging test. It uses very low levels of x-rays to measure how dense your bones are. DEXA stands for “dual-energy X-ray absorptiometry.” Medical experts consider DEXA scans to be the most useful, easy, and inexpensive test for helping to diagnose osteoporosis.

Tests for Bone Strength

If you are a woman postmenopause or a man who is age 50 or older, your bone mineral density test result will be a T-score. A T-score is the difference between your bone mineral density and 0, which is the bone mineral density of a healthy young adult.

The lower your T-score, the higher your risk of bone fracture. What does a T-score mean?

If your T-score is: 1 or higher, your bone is healthy.

–1 to –2.5, you have osteopenia, a less severe form of low bone mineral density than osteoporosis.

–2.5 or lower, you might have osteoporosis.

If you are a premenopausal woman or a man younger than age 50, your bone mineral density test result will be a Z-score. Z-scores are also used for children. The Z-score is the difference between your bone mineral density and the average bone mineral density for healthy people of your age, ethnicity, and sex.

What does a Z-score mean?

If your Z-score is –2.0 or less, your bone mineral density is low. This score could mean that you have osteoporosis caused by medications or other diseases and conditions.

Although this article focuses on the damage to older adults due to bicycle impact it must be kept in mind that children between the ages of 3 and 8 are also highly susceptible **to physical damage from collision with these devices.** This topic is for a separate article.

END OF ARTICLE